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Laboratory Investigation of Air-Sea Interfacial Properties in Relation to Gas Exchange and Remote Sensing

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LONG-TERM GOALS

Our long range goals for this project are to: 1) understand the effect of various physical and chemical properties of the air-sea interface on gas exchange, and 2) characterize the sea surface texture and turbulent boundary layers. These studies will provide a basis for future work on the active and passive microwave remote sensing of the sea surface and the estimation of surface wind vectors and gas transfer velocities from such information.

OBJECTIVES

This project is an experimental study of wave dynamics, boundary layer turbulence, and gas exchange in a salt-water wind-wave tank. Our objectives are: 1) to relate surface texture and boundary layer turbulence to imposed surface wind stress and gustiness, and atmospheric stability to provide insight into the factors controlling remote sensing of the ocean surface, and 2) to relate direct measurements of air-sea gas fluxes to the surface water chemistry and texture and boundary layer turbulence.

APPROACH

Our approach is to carry out laboratory experiments under controlled conditions, in which we can extensively characterize the state of the fluids and interface. The experiments will be carried out using a new facility, the Air-Sea Interaction Salt-water Tank (ASIST). ASIST is a linear, recirculating wind/wave tank. During these experiments, water surface textures will be characterized using an imaging slope gauge and scanning slope gauge. Turbulence measurements in air and water will be made using hot x-films and a conical hot film probe carried by a wave follower. Turbulence

measurements and visualization in the water will also be made using particle image velocimetry. Gas exchange will be studied using eddy correlation flux measurements involving fast-response chemical detection for carbon dioxide via IR absorption, and for other gases (such as dimethylsulfide, ammonia, and sulfur dioxide) by chemical ionization mass spectrometry. The key personnel involved in the project are Drs. Eric Saltzman (gas exchange), Mark Donelan (turbulence, wave properties, and remote sensing), and Warren De Bruyn (mass spectrometry).

WORK COMPLETED

We have devoted the first year of the project to the completion of the ASIST wind/wave facility, and the procurement and development of new instrumentation. At present, all of the major components of the ASIST facility have been purchased, the physical site has been renovated. Assembly and testing of components is underway. The chemical ionization mass spectrometer is fully designed and most components have been fabricated or purchased. We have devoted considerable effort to software development to enable high frequency chemical measurements to be acquired on the same time base as the physical turbulence measurements. Bench testing of the instrument will begin later this fall. We will begin integration of the new instrumentation into the ASIST facility during the second project year, after completion of the facility.

RESULTS

We have not yet begun experiments, so no scientific results have been obtained.

TRANSITIONS

We expect that this project will eventually result in two types of transitional developments: 1) a flux measurement capability for eddy-correlation measurements of trace gases at sea, and 2) improved algorithms relating the state of the air/sea interface to remotely sensed properties.

RELATED PROJECTS

This project is closely related to a DURIP award for the construction of the ASIST wind/wave facility.